RESEARCH REPORT

NO. 2002-RR7

Trade Liberalization and Pollution: Evidence from the Philippines

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This report assesses the environmental impact of the trade liberalization reforms that took place in the Philippines in the 1990s. It finds that trade liberalization has improved the environmental performance of the country's manufacturing industries with respect to a number of pollutants. The improvements are modest, however, and could be enhanced if trade liberalization was complemented by well-enforced environmental policies.

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Can Free Trade Be Clean Trade?

EEPSEA POLICY BRIEF • No. 2002 - PB7

The environmental impact of global trade is high on the international agenda. Among other concerns, some commentators fear that freer trade will shift industrial production to developing countries where ',

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A new study ha...

liberalization in the Philippines on the country's environmental performance. It finds that, far from creating a pollution haven, trade →

A summary of EEPSEA Research Report 2002-RR7, Trade Liberalization and Pollution: Evidence from the Philippines, by Rafaelita M. Aldaba and Caesar B. Cororaton, (Philippine Institute for Development Studies, 106 Amorsolo Street, Legaspi Village, Makati City, Philippines. Contact: afita@mail.pids.gov.ph)

Trade reform has had *po*

liberalization may actually have helped clean up the country's environment. In light of this, the researchers recommend that the government of the Philippines should continue the trade liberalization process and augment it with well-enforced environmental policies that encourage clean technology and reduce pollution.

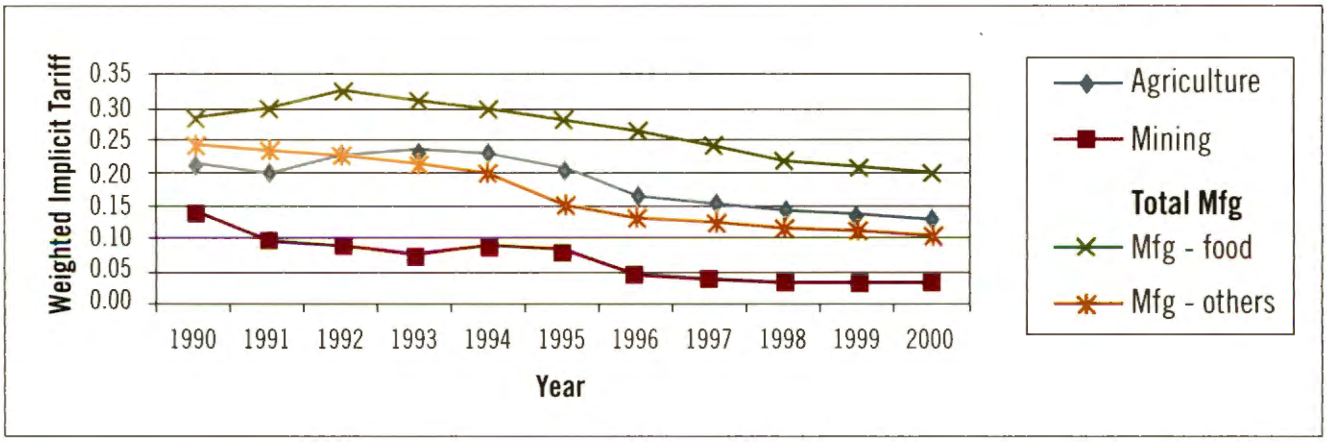
The Impact of Trade Reforms

The report was produced by Rafaelita M. Aldaba and Caesar B. Cororaton, from the Philippine Institute for Development Studies. They aimed to assess the environmental impact of the trade liberalization process that was carried out in the Philippines in the 1990s. These trade reforms not only narrowed tariff ranges on many goods but also eliminated many restrictions, such as import licenses and import bans. By 1996, the number of import restrictions had fallen dramatically and covered only 3% of the Philippine Standard Commodity Classification (PSCC) lines. Average implicit tariffs are estimated to have declined from 28.6% in 1990 to 16.8% in 2000.

These trade reforms brought about significant changes in the country's economic structure. There have been substantial shifts of resources both between and within sectors. At the outset of the trade reforms, the industrial sector had the largest share of the economy, at 40.5%. By 2000, its share stood at only just over 37%. In comparison, the service sector grew from almost 40% to over 43% and is now the country's largest economic sector.

Modeling the Impact of Liberalization

The researchers focused their study on the pollution caused by manufacturing industries in the Philippines. The companies in this sector are key sources of many air and water pollutants. The researchers analyzed the impact of tariff reforms on this sector using a computable general equilibrium (CGE) model. CGE models are macroeconomic simulations that have been applied to a wide range of issues such as taxation and trade policy. The researchers used their model to look at the impact of trade reforms on pollution intensity, industry output, resource allocation, income levels and income distribution. They compared what happened between 1991 and 1999 during liberalization to what would have happened if the policies in place in 1991 had been maintained. Data was gathered from a number of sources including government tariff records. Unfortunately the researchers found that data on both total pollution loads and pollution



Implicit Tariffs: Major Sectors

ive effects in the Philippines

intensities in the Philippines was very limited. The best available information was the data sets of the Philippine Environment and Natural Resources Accounting Project (ENRAP). This project estimated air and water pollution by industry using emission factors and rapid assessment methodologies devised by the World Health Organization (WHO) and the US Environmental Protection Agency (EPA).

The Effects of Trade

Overall the researchers found that trade reforms had boosted the economy and brought about improvements in both income and income distribution. They found that the reform program had increased imports and raised real GDP growth by 0.32% per year from 1991 to 1999. They found that this positive effect on GDP growth had, in the second half of the decade, been translated into slightly higher direct and indirect tax revenues for the government. For the man in the street, they found that trade liberalization had raised the average wage rate by 1.79% per year from 1996 to 1999. The researchers found that there had also been some significant changes in the structure of the manufacturing sector. In 1990, consumer goods - such as food products and beverages - comprised the bulk of manufacturing activity. However, during the 1990s, a shift towards intermediate goods - such as chemicals and textiles - became evident.

The Pollution Picture

The environmental effect of these economic changes was small but generally positive. The researchers reported that, even without changes in environmental policies, trade liberalization had improved the environmental performance of the country's manufacturing industries with respect to a number of key pollutants. They found that particulate matter (PM) pollution had declined by 0.25%, biological oxygen demand (BOD5) by 0.09% and suspended solid (SS) pollution by 0.03%. On the negative side of the balance sheet, they found that tariff reforms had resulted in slight increases in SOx, NOx, CO, and VOC emissions. Although their model did not include the impact of trade liberalization on natural resource depletion, the researchers found that most primary production had been reduced by the reforms. They found that agricultural output had declined by 0.19% from 1991 to 1999, while mining fell by 0.54%. Forestry and fishing decreased by 0.21% and 0.27%, respectively, during the same period. From this, the researchers deduced that trade liberalization probably resulted in a reduced depletion of natural resources.

Adding Technology to the Picture

Environmental technology is often touted as one way to mitigate the negative impact of economic development. To see what role such innovation might have in the Philippines, the researchers undertook a sensitivity analysis. This was designed to provide some broad insights into how improved technology might change the impact of trade liberalization. It investigated the implementation of technology that would bring about a 5% lower pollution coefficient in seven key industrial sectors. Not surprisingly, the researchers found that when technological improvement was added to trade liberalization, the level of all industrial pollutants (including SOx, NOx, CO, and VOC emissions) dropped.

Why Does Trade Reform Help?

To explain their overall findings, the researchers noted that trade reforms may improve environmental quality through the generation of higher incomes which, in turn, lead to improved technology and so, to reduced emissions. Rapid growth, they argued, produces investment in new capital goods, which are likely to be cleaner. Moreover, improvements in income due to trade liberalization intensify the political pressure for environmental clean up and for greater investments in clean production technologies. In light of this, the researchers argue that trade reforms are compatible with efforts to protect the environment to the extent that they eliminate policy distortions, create effective competition, promote economic growth and improve the efficiency of resource use.

Policies and Priorities

Despite this positive message, the researchers noted a number of limitations in their study. The most severe of these was the lack of data for estimating emission coefficients in the Philippines. To allow better monitoring of impacts in the future, the researchers recommended that the regulating body, Department of Environment and Natural Resources, (DENR), improve its monitoring, data collection and management capabilities.

Overall, the researchers recommended that the government continue its trade liberalization policies as well as other economic reforms aimed at promoting competition and efficiency in the economy. Their study does not support the contention that freer trade is inevitably damaging to the environment. Instead it suggests that trade liberalization has had mild positive effects on the Philippines' environment. But the modest size of these improvements shows that trade policy alone will not produce the big advances needed. Attention should be re-focused on the design and enforcement of policies specifically targeted at reducing environmental damage. The debate over trade and environment should not distract policy-makers from this task.

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Trade Liberalization and Pollution: Evidence from the Philippines

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November, 2002

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This paper was first presented at the EEPSEA 16th Biannual Workshop held at EDSA Shangri-La Hotel in Manila on May 24, 2001. It was also presented at the PIDS Brown Bag Seminar in Makati City on June 13, 2001 and at the PIDS Pulong Saliksikan on July 6, 2001.

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TRADE LIBERALIZATION AND POLLUTION:

EVIDENCE FROM THE PHILIPPINES

Rafaelita M. Aldaba and Caesar B. Cororaton

EXECUTIVE SUMMARY

The paper assesses the impact of trade reforms in the Philippines on pollution using computable general equilibrium (CGE) model simulations. It focuses on the manufacturing industry and its pollution effects and examines whether trade liberalization is compatible with efforts to promote environmental protection.

Generally, the results of the CGE simulations showed that trade reform is output augmenting and income improving. The overall impact on pollution is very little. The overall change in the level of emission for all pollutants is very small relative to the case where there is no tariff reform program. The results of the sensitivity analysis indicate that a change in production technology is a major factor that can check the problems of pollution in the process of industrialization.

1.0 INTRODUCTION

Trade liberalization is an economy-wide policy that narrows the spread of tariffs, lowers average tariffs and eliminates quantitative restrictions, with its effect depending on the level and structure of effective protection rates. As trade is an important agent of growth and structural change, it can lead to higher incomes and reallocation of production and consumption. Trade liberalization can affect the environment primarily through increased or decreased emissions of harmful substances into the air, water and/or land including disposal of solid wastes. An expansion in the industrial sector output affects pollution in two ways: first, it increases the total volume of pollutants in the short and medium terms and second, it changes the pollution intensity of industrial output.

The Organisation for Economic Co-operation and Development (OECD 1994, 1995) summarizes the environmental effects of trade liberalization into five main categories:

- Scale effects are associated with the overall level of economic activity resulting from trade liberalization. Positive scale effects may result from higher economic growth particularly when appropriate environmental policies are present. Negative scale effects may occur when higher economic growth increases pollution and causes faster draw down of resources due to the absence of appropriate environmental policies.

- Structural effects are associated with changes in the patterns of economic activity resulting from trade liberalization. Positive structural effects may result when trade liberalization promotes efficient allocation of resources and patterns of consumption. Negative structural effects may occur when appropriate environmental policies do not accompany changes in patterns of economic activity.

- Product effects are associated with trade in specific products, which can enhance or harm the environment. Positive product effects may result from increased trade in goods, which are environmentally beneficial like energy-efficient machinery while negative product effects may result from increased trade in goods which are environmentally sensitive like hazardous wastes.

- Technology effects are associated with changes in the way products are made depending on the technology used. Positive technology effects may result when the output of pollution per unit of economic product is reduced.

- Regulatory effects are associated with the legal and policy effects of trade liberalization on environmental regulations, standards and other measures.

These effects may have a positive or negative impact on the environment. In general, studies have shown that the impact of trade liberalization on the environment is positive, provided it is accompanied by effective environmental policies (OECD 1995). Trade liberalization improves the efficiency of resources allocation, promotes economic growth and increases general welfare. Therefore, it is viewed as a positive agent that can provide resources for the improvement of the environment.

Industrial production has a number of potential environmental impacts. Water pollution results from wastewater discharges that are high in biochemical oxygen demand (BOD5) and total suspended solids (TSS). Food industries and other agriculture-based industries such as processing of coconut, sugar cane, rice corn, pineapple, tobacco, piggeries, beverage and slaughterhouses are the major sources of water pollution. Other major sources include pulp mills, chemical plants, pharmaceuticals, refineries, metal finishing and textile manufacturing which contain varied chemical compositions. Air pollution arises from emission of gases and particulates. The major sources of air pollution are cement, oil refineries and chemical plants. Toxic and hazardous wastes result from wastewater discharge containing heavy metals, solvents, and acid/alkali wastes. The major sources of toxic and hazardous wastes are the electronics and metal finishing industries.

The Philippine Environment and Natural Resources Accounting Project's (ENRAP) estimation indicated that in 1992, the household sector was the major source of air pollutants such as fine particulates that are less than 10 micron in diameter (PM_{10}), volatile organic compounds (VOC), and carbon monoxide (CO). Households accounted for 59% of fine particulates (PM), 66% of PM_{10}, 85% of VOC, and 86% of CO. Electricity generation and manufacturing industries were the primary sources of sulphur dioxide (SO_2), with electricity generation accounting for the bulk of the emission. In 1992, electricity generation accounted for 53% of the total SO_2 emission while manufacturing industries accounted for 32%.

The household sector was the largest source of BOD5 with a share of 44% of the total BOD5 discharges in 1992. Industries accounted for 29% of BOD5, the bulk of which could be attributed to livestock production and services sector. Manufacturing accounted for about 2% of the total BOD5. The manufacturing sector was the primary source of total dissolved solids (TDS) with food, beverages, and tobacco contributing around 93% of the total TDS discharges in 1992. Manufacturing also accounted for 32% of oil and grease.

This paper aims to assess the environmental impact of trade liberalization in the Philippines, which was carried out with much vigor in the 1990s. In particular, the study will focus on the manufacturing industry and its effects on pollution. Section II discusses the trade policy changes between the 1980s and the 1990s. Section III presents a review of selected literature, Section IV assesses the impact of trade liberalization on industrial pollution using a computable general equilibrium model, and section V presents a qualitative analysis of the environmental effects of trade liberalization on sugar milling refining and cement industries. Apart from food processing, oil refineries and chemical plants, sugar milling and cement manufacturing are among the major industrial sources of water and air pollution in the Philippines. The final section summarizes the findings and presents the policy recommendations of the paper.

2.0 ANALYSIS OF THE PHILIPPINE MANUFACTURING INDUSTRY

2.1 Trade Policy Reforms

The first major trade policy reform in the Philippines was implemented in 1981 as part of the conditions associated with a series of World Bank structural adjustment loans. It consisted of a two-pronged trade reform program, which combined tariff reform and import liberalization, but without an accompanying exchange rate policy. The program was implemented over a five-year period beginning 1980. There were plans to reduce the range of nominal tariffs from zero to 100% to a range of between 10 and 50% under the trade reform program. However, the program was suspended in 1983 due to the economic crisis that plunged the country into severe balance of payments problems. Deregulated items were put back in the regulated list, and eventually, a strict foreign exchange system was adopted.

The second reform, which covered the years 1991 to 1995, was legislated during the Aquino administration through Executive Order (EO) 470 signed in July 1991. This narrowed the tariff range to within a 3 to 30% by the year 1995. The third most important tariff reform was pursued during the Ramos administration. EO 264 issued in August 1995 further reduced the tariff range, mostly to 3% and 10% levels and decreased the ceiling rate on manufactured goods to 30% while the floor remained at 3%. The goal was to create a four-tier tariff schedule: 3% for raw materials and capital equipment which were not locally available, 10% for raw materials and capital equipment which were locally available, 20% for intermediate goods, and 30% for finished goods.

The trade reforms did not only narrow the tariff range but also eliminated import restrictions, which were mainly in the form of import licenses and outright import bans. Between 1986 and 1989, import restrictions on 1,471 Philippine Standard Commodity

Classification (PSCC)[1] lines were lifted. This represented a decline in the number of regulated items as a percentage of the total number of PSCC lines from around 32% in 1985 to only 8% in 1989. Subsequent years witnessed the liberalization of a few more items, which brought down the percentage of regulated items to about 4% in 1995. The number of import restrictions fell to only about 3% of the total number of PSCC lines in 1996.

Table 1 Weighted Implicit Tariff Rates by Sector

Sectors	*1990*	*1992*	*1994*	*1995*	*1996*	*1998*	*2000*
Palay & Corn	0.56	0.60	0.70	0.66	0.48	0.45	0.43
Fruits & Vegetables	0.21	0.21	0.21	0.20	0.13	0.09	0.06
Coconut & Sugar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Livestock & Poultry	0.05	0.04	0.03	0.03	0.03	0.03	0.02
Fishing	0.17	0.27	0.19	0.14	0.10	0.06	0.06
Other Agriculture	0.11	0.13	0.11	0.09	0.23	0.18	0.14
Forestry	0.18	0.12	0.12	0.11	0.05	0.03	0.03
Mining	0.14	0.09	0.08	0.08	0.04	0.03	0.03
Rice & Corn Milling	0.39	0.50	0.50	0.50	0.51	0.47	0.44
Milled Sugar	0.44	0.47	0.42	0.39	0.34	0.25	0.23
Meat Manufacturing	0.11	0.15	0.12	0.09	0.10	0.08	0.06
Fish Manufacturing	0.17	0.26	0.19	0.11	0.11	0.07	0.06
Beverage & Tobacco	0.38	0.39	0.38	0.38	0.24	0.16	0.15
Other Food Manufacturing	0.24	0.23	0.20	0.18	0.18	0.13	0.10
Textile Manufacturing	0.25	0.23	0.21	0.12	0.12	0.08	0.06
Garments & Leather	0.27	0.27	0.27	0.16	0.16	0.11	0.10
Wood Manufacturing	0.18	0.19	0.16	0.14	0.14	0.09	0.09
Paper & Paper Products	0.27	0.24	0.20	0.17	0.17	0.11	0.11
Chemical Manufacturing	0.30	0.26	0.25	0.18	0.16	0.10	0.10
Petroleum Refining	0.11	0.12	0.13	0.11	0.03	0.02	0.02
Non-metal Manufacturing	0.28	0.26	0.25	0.19	0.17	0.13	0.08
Metal Manufacturing	0.27	0.25	0.23	0.22	0.21	0.15	0.13
Electrical Equipment Manufacturing	0.23	0.20	0.14	0.10	0.09	0.23	0.23
Transport & Other Machinery	0.25	0.28	0.22	0.15	0.14	0.12	0.09
Other Manufacturing	0.18	0.14	0.12	0.09	0.09	0.06	0.05

Source: Cororaton, C., 1998.

The 'tariffication' of quantitative restrictions began in 1992 with the legislation of EO 8 covering 153 commodities whose quantitative restrictions were converted into tariff equivalent rates. EO 8 increased the tariff rates of relevant commodities by 100% of their old levels. With the country's accession to the World Trade Organization in the GATT-Uruguay Round, EO 313 and Republic Act (RA) 8178 (1996) were issued. EO 313 increased the tariff rates on sensitive agricultural products while RA 8178 lifted the quantitative restrictions on these products. Minimum access volume was also defined for these products. The government has expressed its intention to adopt a uniform 5% tariff by the year 2004. This is also in line with the country's commitments to the

[1] The Philippine Standard Commodity Classification is a classification scheme used in the distribution of various commodities that enter foreign and domestic trade and is patterned after the UN Standard International Trade Classification (SITC).

ASEAN Free Trade Area-Common Effective Preferential Tariff (AFTA-CEPT) agreement where the tariffs on most products is expected to be reduced to a range of between zero and 5% by 2002.

Table 1 presents estimates of implicit tariff rates using price comparison (ratio of domestic prices to border prices) for the period 1990 to 2000. Average implicit tariffs are expected to decline from 28.6% in 1990 to 16.8% in 2000 (Manasan and Querubin 1997). It is evident from the table that beginning 1995, the average implicit tariff rates for all major sectors would decline. Palay and corn would fall from 0.66 in 1995 to 0.43 in 2000. Fishing would decline from 0.14 to 0.06 between 1995 and 2000 while forestry would decrease from 0.11 to 0.03 during the same years. Under manufacturing, beverage and tobacco would fall from 0.38 to 0.15, chemical manufacturing will decline from 0.18 to 0.10, and petroleum refining would decrease from 0.11 to 0.02 while non-metal manufacturing would decline from 0.19 to 0.08. An increase in implicit tariffs is evident for some sectors like other agriculture and electrical equipment manufacturing.

Table 2 Effective Protection Rates

Sectors	*1990*	*1992*	*1994*	*1995*	*1996*	*1998*	*2000*
	Percentage (%)						
Sectoral Weighted Averages	29.4	34.6	30.5	24.8	27.3	19.1	14.9
Agriculture, Fishery & Forestry	27.1	29.1	29.8	28.5	21.6	18.6	17.2
Agriculture	32.0	33.6	36.6	35.5	28.6	25.3	23.6
Fishery	17.1	23.6	18.6	16.1	9.5	6.2	4.6
Forestry	17.4	11.2	10.7	10.2	2.8	2.9	2.9
Mining	1.0	1.5	0.6	1.1	-1.2	0.3	0.3
Manufacturing	31.9	38.7	32.5	24.8	31.1	20.3	14.9
Food Processing	38.2	60.3	44.4	34.2	51.4	37.6	28.2
Beverages & Tobacco	51.6	49.1	47.9	48.1	25.6	16.4	7.9
Textile, Garments, & Footwear	25.0	24.1	21.8	13.1	12.7	11.1	8.4
Wood & Wood Products	32.8	20.1	19.2	15.8	20.6	17.4	10.3
Furniture & Fixtures	21.1	22.7	14.9	13.1	14.4	14.2	11.8
Paper/Rubber/Leather/Plastic	32.0	28.7	24.8	20.5	19.6	13.3	8.5
Chemicals & Chemical Products	28.0	21.8	21.4	14.8	11.5	7.3	5.8
Non-metallic Mineral Products	21.9	19.0	27.5	18.0	29.4	4.2	3.3
Basic Metals & Metal Products	22.6	20.1	18.5	15.2	13.1	9.4	7.4
Machinery	24.2	23.2	17.2	11.3	10.5	8.1	6.3
Miscellaneous Manufactures	20.4	17.8	14.4	10.2	10.2	6.0	3.8

Source: Manasan and Pineda 1999

Table 2 indicates that the trade policy reforms in the 1990s resulted in a significant reduction in the average effective protection rate[2] for the whole economy. The average effective protection rate dropped from 31% in 1994 to 19% in 1998. Within manufacturing, food processing (including rice, corn, coconut, and sugar milling) had

[2] The effective protection rate (EPR) concept is used to measure protection given to the output and input of a specific activity. The net effect of protection on output and input is indicated by the protection of the activity's value added. Thus, the EPR is computed as the proportionate increase in domestic value added over free trade value added.

the highest protection at 38% in 1998 while non-metallic mineral products had the lowest protection level at 4%. Agriculture was expected to receive effective protection of 25% in 1998 and 24% by 2000. The effective protection for manufacturing was expected to decline from 20% in 1998 to 15% in 2000.

2.2 Performance and Structure

With the introduction of trade reforms, profound changes are expected in the industry structure involving both substantial shifts of resources between economic sectors and restructuring within industries. Trade liberalization is expected to drive the process of restructuring and reallocation of resources within and across sectors of the economy such that unprofitable activities contract while profitable ones expand.

Table 3 reveals that over the last two decades, there has been very little systematic movement of resources in industry and manufacturing. It is the services sector that has been experiencing a major increase in size. Since 1980, the share of services has been increasing from about 36% to 44% in 2000. At the outset of the trade reforms, industry had the largest share of 40.5%. Its share declined between 1980 and 1985, although some gradual increases could be observed from 1988 to 2000. The share of agriculture and fishery value added slightly dropped from 21% in 1980 to 19% in 2000. During the same period, the share of forestry dropped substantially from 3% to 0.06%, while mining and quarrying declined, albeit minimally, from 1.5% to 1.06%.

Table 3 Structure of Value Added [[a]1985=100]

Year/Sectors	*1980*	*1985*	*1988*	*1990*	*1995*	*1998*	*1999*	*2000*
	Percentage (%)							
Agriculture	23.5	19.4	18.81	18.01	17.55	18.52	19.0	18.98
Agriculture & Fishery	20.5	18.16	17.45	17.19	17.37	18.37	18.92	18.92
Forestry	3.0	1.24	1.36	0.82	0.18	0.15	0.08	0.06
Industry	40.52	27.69	28.11	28.63	28.81	38.6	37.77	37.41
Mining & Quarrying	1.5	1.64	1.42	1.24	1.02	1.14	1.01	1.06
Manufacturing	27.6	19.86	20.51	20.61	20.63	23.65	23.27	23.74
Services	35.98	31.86	32.85	34.11	35.07	42.88	43.23	43.61
Total	100	100	100	100	100	100	100	100

Source: National Statistical Coordination Board, National Income Accounts.

a Constant 1985 prices

Table 4 presents the distribution of manufacturing value added for the years 1990, 1994, 1996 and 1997. In 1990, consumer goods comprised the bulk of manufacturing value added with a share of 45%, although this dropped to 39% in 1994. As the share of consumer goods continued to drop, a shift towards intermediate goods became evident. In 1996, intermediate goods accounted for the largest share of 38%, but slightly declined to 36% in 1997. Capital goods also registered an increasing share from 19% in 1990 to almost 30% in 1997.

Table 4 Distribution and Structure of Manufacturing Value Added

Manufacturing Sector	*1990*	*1994*	*1996*	*1997*
	Percentage (%)			
Food Products	23.55	17.86	17.66	18.07
Beverages	9.60	8.87	6.38	6.35
Tobacco	4.95	5.53	4.16	3.76
Wearing Apparel	5.57	6.26	3.91	3.91
Furniture	1.01	0.79	0.67	0.78
Consumer Goods	44.68	39.31	32.78	32.86
Leather & Leather Products	0.43	0.50	0.62	0.67
Wood & Cork Products	1.79	1.00	0.89	0.90
Textiles	4.58	3.10	2.01	2.07
Paper & Paper Products	2.15	2.05	2.24	1.96
Printing & Publishing	1.30	1.48	1.18	1.29
Petroleum Refineries	5.76	8.07	13.58	11.89
Petroleum & Coal Products	0.03	0.05	0.05	0.11
Industrial Chemicals	3.25	2.63	1.71	1.82
Other Chemicals	9.03	10.40	8.66	8.42
Rubber Products	1.83	1.38	0.66	0.50
Plastic Products	1.29	1.98	1.93	2.05
Glass & Glass Products	1.01	1.05	0.97	0.76
Cement	1.41	2.16	2.80	2.61
Non-metallic Mineral Products	1.64	1.43	1.04	1.17
Intermediate Goods	35.50	37.27	38.35	36.23
Iron & Steel	2.76	4.58	2.95	2.79
Nonferrous Metal Products	1.37	1.07	0.83	0.85
Fabricated Metal Products	1.52	1.85	1.57	1.97
Machinery except Electrical	0.87	1.14	1.22	1.25
Electrical Machinery	9.12	9.92	13.46	15.00
Transport Equipment	3.00	3.56	0.97	1.01
Professional & Scientific Equipment	0.13	0.30	6.86	7.12
Capital Goods	18.79	22.42	27.85	29.99
Miscellaneous Manufactures	1.03	1.00	1.01	0.92
Total	100.00	100.00	100.00	100.00

Source: Philippine National Statistics Office (various years)

In 1997, food processing/manufacturing and beverages were the most important sub-sectors under consumer goods, as they comprised 24% of the total manufacturing value added. In the intermediate goods sector, other chemicals and petroleum refineries represented 20% of the total manufacturing value added while in the capital goods sector, electrical machinery together with professional and scientific equipment were the top sub-sectors with their combined shares of about 22% of the total manufacturing value added.

3.0 TARIFF REFORMS AND POLLUTION: A CGE ANALYSIS

Empirical analysis has used CGE models to evaluate the effects of economic policies on the environment. Lee and Roland-Holst (1997), Beghin et al. (1996), Beghin et al. (1997), and Beghin et al. (1999), used CGE models to analyze the links between trade policies and the environment. In the Philippines, there are currently very few empirical studies linking trade policy and the environment. Intal et al. (1994) applied a simple, multi-industry, partial equilibrium simulation model to assess the effects of trade liberalization on the economic structure and on the environment. The model linked changes in industry outputs to changes in effective protection rates and the real exchange rate. It was static and assumed fixed input-output ratios and constant factor prices. Using the same partial equilibrium framework, David et al. (2000) assessed the effects of substantial trade liberalization policies implemented in the 1990s on water pollution. Cruz and Repetto (1992) applied a CGE model to assess the impact of trade reforms but did not quantify their environmental effects as these were not modeled explicitly. Orbeta (1999) estimated the effects of tariff changes on the environment using the ENRAP input-output model. The model assumed fixed input ratio in each industry and constant returns to scale in production. Like the Intal et al. study, Orbeta assumed constant pollution intensities prior to and after the implementation of tariff changes.

In this section, the impact of tariff reforms in the 1990s on pollution is analyzed through simulation exercises using a CGE model. This model is calibrated to Philippine data and pollution intensities based on ENRAP and World Bank Industrial Pollution Projection System (WB-IPPS). The impact of the reforms on industry output, resource allocation, income levels and income distribution are also examined. Lastly, the impact of an improvement in production technology is assessed through simulation experiments.

3.1 Model Structure

The core equations of the Philippine computable general equilibrium model (PCGEM) used in the simulation are presented in Appendix 1. The model is a standard, non-linear CGE model with 34 production sectors, 3 factor inputs (labor, variable capital, and capital), and 10 household groups. The model was calibrated to the 1990 social accounting matrix and sectoral tariff revenue (Intal et al. 1994).

The equilibrium conditions in the model are: (a) total factor demand is equal to total supply; (b) zero profit condition; (c) sectoral supply is equal to sectoral demand for commodities; (d) nominal exchange rate is the numeraire and (e) total savings is equal to total investment. Total investment and government expenditure are fixed while foreign savings is assumed to be endogenous. This model closure implies that the tariff reform program is financed by foreign capital inflow, which is not totally unrealistic considering the fact that when the implementation of the program intensified in the mid-1990s, capital inflow from abroad surged.

The parameters used in the model are presented in Table 5. These parameters are the coefficients in the Cobb-Douglas value added equations, the Armington and the constant elasticity of transformation (CET) elasticities.

Few modifications were introduced into the core equations of PCGEM in order to capture the following: (i) time lagged effects of tariff reform, (ii) emission factors, and (iii) additional indirect tax based on emission.

Dynamic Bloc. Labor supply in t is specified as:

(1) $l_t = l_{t-1}*(1+lgr_t)$

where l_{t-1} is labor supply of the previous period and lgr_t is growth of labor in the current period. Similar specification is used for the supply of variable capital.

(2) $v_t = v_{t-1}*(1+vgr_t)$

where v_{t-1} is supply of variable capital in the previous period and vgr_t is growth of variable capital in the current period.

Supply of industry capital stock is specified as:

(3) $k_{it} = k_{it-1}*(1 - depr_i) + inv_{it}$

where k_{it} is industry i capital stock in period t, $depr_i$ is depreciation rate and inv_{it} is investment.

Emission. Industry emission levels are calculated using the following equation:

(4) $EMIS_k = \Sigma^n_{i=1}\varepsilon_{ik}*XD_i$

where k = (PM, SO_2, nitrogen oxides (NOx), VOC, CO, BOD5, Suspended Solids (SS)), ε_{ik} are industry effluent intensities of pollutant k, XD_i is the domestic production. The values of the intensities are presented in Table 6 and are further discussed in the next section. Note that the output of domestic production is either consumed locally or exported.

Table 5 Key Parameters in PCGEM

	Production			Armington	CET
Sectors	*Alpha*	*beta*	*Gamma*	*Sigma_m*	*tau_e*
Palay & Corn	0.05	0.94	0.01	3.70	0.30
Fruits & Vegetables	0.18	0.75	0.07	0.85	1.50
Coconut & Sugar	0.38	0.21	0.41	1.30	2.00
Livestock & Poultry	0.14	0.81	0.05	1.40	0.30
Fishing	0.12	0.68	0.21	1.10	1.50
Other Agriculture	0.37	0.31	0.32	0.90	0.30
Forestry	0.21	0.09	0.70	0.80	0.30
Mining	0.41	0.07	0.52	1.10	1.50
Rice & Corn Milling	0.12	0.27	0.62	3.70	0.30
Milled Sugar	0.22	0.00	0.78	4.10	0.80
Meat Manufacturing	0.21	0.18	0.61	1.50	0.80
Fish Manufacturing	0.15	0.46	0.39	1.10	2.00
Beverage & Tobacco	0.19	0.05	0.76	0.30	1.50
Other Food Manufacturing	0.19	0.18	0.63	0.20	0.70
Textile Manufacturing	0.48	0.23	0.29	0.70	0.70
Garments & Leather	0.32	0.44	0.24	0.20	2.50
Wood Manufacturing	0.25	0.34	0.40	0.50	1.50
Paper & Paper Products	0.33	0.19	0.48	0.60	0.90
Chemicals Manufacturing	0.25	0.08	0.67	0.60	1.30
Petroleum Refining	0.08	0.00	0.92	0.60	0.30
Non-Metal Manufacturing	0.31	0.25	0.45	0.60	1.50
Metal Manufacturing	0.35	0.19	0.47	1.80	1.50
Electrical Equipment Manufacturing	0.55	0.00	0.45	1.80	3.00
Transport & Other Machinery Manufacturing	0.53	0.00	0.47	1.90	1.30
Other Manufacturing	0.18	0.27	0.55	1.10	0.60
Construction	0.54	0.11	0.36	0.20	0.30
Electricity Gas and Water	0.23	0.00	0.77	0.20	0.30
Financial Sector	0.36	0.02	0.63	0.20	0.30
Private Education	0.62	0.21	0.17	0.20	0.30
Private Health	0.25	0.62	0.13	0.20	0.30
Public Education	0.97	0.00	0.03		
Public Health	0.95	0.00	0.05		
General Government	0.96	0.00	0.04		
Other Services	0.16	0.50	0.34	0.20	0.30

Note: The parameters represent coefficients in the Cobb-Douglas value added equations, the Armington and the CET elasticities.

Income Index. This indicator measures changes in consumption and income. It does not incorporate the pollution effects on overall consumer welfare. The income measure used is the Hicksian equivalent variation (EV). This measure takes the old equilibrium incomes and prices and computes the change needed to achieve new equilibrium utilities (Shoven and Whalley 1984). Computationally, this is given by the following formula:

(5) $EV = [(U^n - U^0)/U^0]*I^0$

where U^n, U^0, I^0 denote the new and old levels of utility and income, respectively. The model also generates Gini coefficient as the indicator of income inequality.

3.2 Description of Data

3.2.1 Tariffs

Figure 1 shows how tariff rates changed in the 1990s (refer to Table 1 for a more detailed sectoral breakdown of the tariff changes). These represent implicit tariff rates computed by Manasan and Querubin (1997), using price comparison. Based on the movement of the rates over time, the entire period may be divided into two sub-periods for purposes of the analysis: 1990-1994 and 1995-2000. One observes that the program intensified in the second period with implicit tariffs of major sectors declining until the turn of the century. Also, another important feature that needs to be highlighted is the increase in implicit tariffs for agriculture until 1994. This was the effect of 'tariffication' of quantitative restrictions on several agricultural crops. To date, only rice is covered by a quantitative restriction.

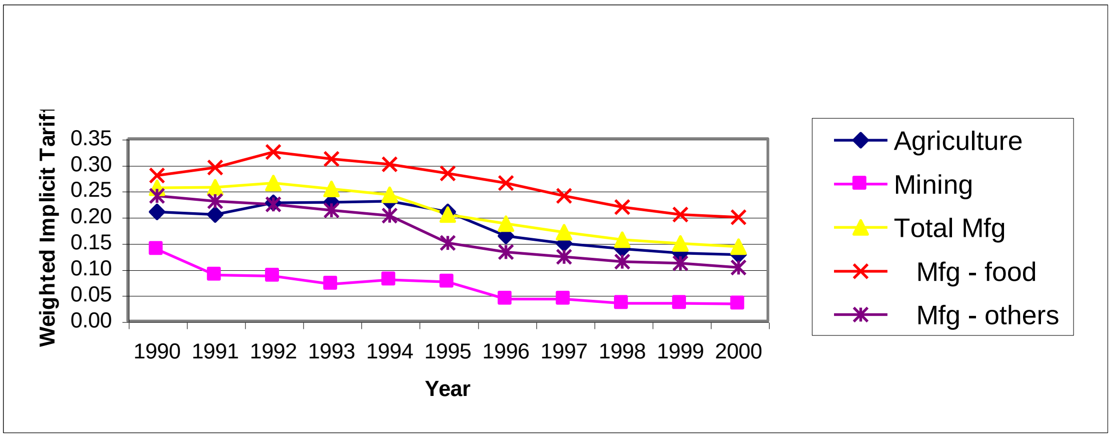

Figure 1 Implicit Tariffs: Major Sectors

3.2.2 Pollution Intensities

Pollution intensity is expressed as a ratio of pollution per unit of manufacturing activity:

Pollution Intensity = Pollution Load/Total Manufacturing Activity.

Currently, there are no comprehensive data on either total pollution load or pollution intensities in the Philippines. Data on industrial air and water pollution are sparse and often unreliable. The Department of Environment and Natural Resources (DENR) Environmental Management Bureau (EMB) is responsible for monitoring emissions and effluents of industrial firms with more than 10 employees as well as maintaining environmental quality data bases.

A review of the DENR Regional Industrial Emission and Effluent Reports revealed very little information on pollution either by region or by industrial sector. Interviews with the staff of the EMB and DENR's Regional Offices attributed this to resource constraints. Other reasons that were cited include the lack of necessary equipment to monitor pollution, lack of technically capable staff, lack of funds for the maintenance and repair of pollution equipment, and lack of support from management staff who are, sometimes, more concerned with other environmental issues such as the conservation of natural resources.

Table 6 ENRAP Pollution Intensity

Sectors	*SO_2*	*NOx*	*CO*	*VOC*	*PM*	*BOD5*	*SS*
	pounds/current 1990 Philippine pesos million output						
Palay & Corn	0.4	1.1	10.9	1.7	1.3	19,427.9	3,855,547.1
Fruits & Vegetables	4.1	10.6	57.7	9.7	8.6	442.0	87,711.9
Coconut & Sugar	5.5	14.3	77.9	13.2	11.6	14,441.9	2,866,049.6
Livestock & Poultry	4.1	10.7	58.6	9.9	8.7	18,452.1	132,848.6
Fishing	139.5	271.5	236.4	91.8	-	-	-
Other Agriculture	10.1	26.3	143.4	24.4	21.4	901.7	178,942.9
Forestry	134.6	321.9	1,747.7	293.6	262.7	186,804.7	37,072,095.1
Mining	1,829.7	1,463.7	7,193.7	1,221.4	6,219.7	-	3,697,488.1
Rice & Corn Milling	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Milled Sugar	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Meat Manufacturing	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Fish Manufacturing	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Beverage & Tobacco	424.0	265.2	1,095.8	184.8	222.6	2,698.3	2,816.3
Other Food	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Textile Manufacturing	727.9	269.8	1,097.4	184.6	219.6	1,446.5	679.1
Garments & Leather	41.0	73.0	389.6	66.2	59.5	101.5	157.4
Wood Manufacturing	467.4	1,147.1	6,226.6	1,055.1	1,113.9	36.5	33.7
Paper & Paper Products	1,366.6	504.2	2,817.4	328.8	3,403.7	1,235.1	1,806.0
Chemicals Manufacturing	426.1	218.8	1,057.1	208.8	764.2	213.0	88.9
Petroleum Refining	65.3	120.8	1,465.2	51.9	46.8	75.3	22.2
Non-metal Manufacturing	1,354.3	990.0	1,898.2	321.0	649.6	-	143.1
Metal Manufacturing	688.9	306.0	1,162.3	206.6	4,723.2	25.7	101.3
Electrical Equipment Manufacturing	43.8	90.1	484.8	82.2	73.6	-	604.2
Transport & Other Machinery Manufacturing	143.1	282.9	1,475.6	771.6	227.7	611.1	262.8
Other Manufacturing	17.3	46.3	251.7	42.9	37.9	-	-
Construction	69.0	162.8	882.0	160.0	1,495.9	-	-
Electricity, Gas & Water	11,961.7	2,070.7	130.7	58.9	825.5	0.8	9,825.0
Financial Sector	6.9	18.2	102.7	17.3	15.0	-	-
Private Education	2.3	5.9	31.9	5.4	4.8	-	-
Private Health	6.5	16.8	92.1	1,032.5	13.7	847.1	383.5
Public Education	2.3	5.9	31.9	5.4	4.8	-	-
Public Health	6.5	16.8	92.1	1,032.5	13.7	847.1	383.5
General Government	56.8	142.7	874.1	185.7	155.5	-	27,912.5
Other Services	43.6	81.6	416.7	164.7	158.8	4,770.6	573.6

Note: 2.2 pounds=1 kg

24.3 pesos=1 USD

Given the unfortunate state of industrial pollution data in the country, the only available alternatives are the data sets of the ENRAP. The ENRAP Project estimated air and water pollution by industry using emission factors and rapid assessment methodologies devised by the World Health Organization (WHO) and the United States Environmental Protection Agency (EPA). It applied the WHO rapid assessment method mainly to estimate water pollution loads as well as process emissions and the EPA emission factors to generate emissions from fuel combustion. The ENRAP pollution estimates covered all sectors: agriculture, fishing, forestry, mining, manufacturing, and services. The ENRAP pollution coefficients were derived by matching the ENRAP pollution estimates with output data from the National Statistics Office (see Table 6).

Table 7 WB-IPPS Pollution Intensity

Manufacturing Sectors	*SO_2*	*NOx*	*CO*	*VOC*	*PM*	*BOD5*	*SS*
	pounds/current 1990 Philippine pesos million output						
Rice & Corn Milling	10.6	8.4	1.6	8.9	17.4	-	-
Milled Sugar	206.9	198.6	106.4	35.2	4.3	68.6	98.3
Meat Manufacturing	6.3	64.3	16.1	0.3	0.2	1.0	1.3
Fish Manufacturing	5.6	2.4	0.2	0.1	0.1	18.5	31.5
Beverage & Tobacco	49.6	30.7	3.1	48.5	0.7	18.1	32.7
Other Food	76.2	55.8	23.3	17.3	23.4	42.5	25.1
Textile Manufacturing	66.2	86.3	13.1	27.4	1.7	2.5	3.9
Garments & Leather	1.1	0.4	0.1	1.4	-	0.2	0.3
Wood Manufacturing	72.2	108.9	268.2	159.7	23.5	3.8	17.6
Paper & Paper Products	271.6	151.8	311.0	56.1	15.3	145.7	492.7
Chemicals Manufacturing	179.1	196.3	91.7	151.2	5.1	47.6	175.4
Petroleum Refining	397.5	228.9	206.3	208.7	4.1	4.9	24.6
Non-metal Manufacturing	679.1	346.6	47.7	21.1	550.6	3.0	15.9
Metal Manufacturing	687.9	161.6	698.8	58.8	98.9	26.4	4,154.9
Electrical Equipment Manufacturing	5.0	2.4	2.1	10.5	0.1	0.8	1.2
Transport & Other Machinery Manufacturing	6.8	5.9	13.3	40.9	0.5	0.2	4.1
Other Manufacturing	38.1	18.0	167.0	39.4	6.5	1.6	150.9

2.2 pounds =1 kg

24.3 pesos = 1 USD

Generally, pollution intensities are greater in developing countries than in developed nations. Table 8 compares the ENRAP pollution intensities with the WB-IPPS pollution intensities by taking the ratio of the ENRAP coefficients to the WB-IPPS coefficients. Most of the ENRAP coefficients were found to be substantially higher than the WB-IPPS pollution coefficients especially for PM. The estimated ratios revealed that on average, ENRAP PM coefficients were extremely higher than their WB-IPPS counterparts with a very high ratio of about 1,027. The average ratio of ENRAP CO coefficient to WB-IPPS was found to be around 600 while the average ENRAP BOD5 coefficient to the WB-IPPS was 368. For SS and VOC, the average ratios were 124 and 134. The average ENRAP SO_2 and NOx ratios were relatively low at 12 and 24, respectively.

Table 8 Ratio of ENRAP Pollution Intensity to WB-IPPS Pollution Intensity: Manufacturing Sector

Manufacturing Sector	*SO_2*	*NOx*	*CO*	*VOC*	*PM*	*BOD5*	*SS*
Rice & Corn Milling	20.31	23.36	592.00	17.97	53.62		
Milled Sugar	1.04	0.99	8.90	4.54	216.98	5.96	4.36
Meat Manufacturing	34.17	3.05	58.83	533.00	4,665.00	408.70	329.31
Fish Manufacturing	38.45	81.75	4,736.00	1,599.00	9,330.00	22.09	13.59
Beverage & Tobacco	8.55	8.64	353.48	3.81	318.00	149.08	86.13
Other Food	2.83	3.52	40.65	9.24	39.87	9.62	17.06
Textile Manufacturing	11.00	3.13	83.77	6.74	129.18	578.60	174.13
Garments & Leather	37.27	182.50	3,896.00	47.29		507.50	524.67
Wood Manufacturing	6.47	10.53	23.22	6.61	47.40	9.61	1.91
Paper & Paper Products	5.03	3.32	9.06	5.86	222.46	8.48	3.67
Chemicals Manufacturing	2.38	1.11	11.53	1.38	149.84	4.47	0.51
Petroleum Refining	0.16	0.53	7.10	0.25	11.41	15.37	0.90
Non-metal Manufacturing	1.99	2.86	39.79	15.21	1.18		9.00
Metal Manufacturing	1.00	1.89	1.66	3.51	47.76	0.97	
Electrical Equipment Manufacturing	8.76	37.54	230.86	7.83	736.00		503.50
Transport & Other Machinery Manufacturing	21.04	47.95	110.95	18.87	455.40	3,055.50	64.10
Other Manufacturing	0.45	2.57	1.51	1.09	5.83		
Average	11.82	24.43	600.31	134.25	1,026.87	367.38	123.77

A closer look at the manufacturing sub-sectors indicate that the highest PM ratios are found in fish manufacturing with ENRAP coefficients being 9,330 times higher than WB-IPPS and meat manufacturing with a ratio of 4,665. For CO ratios, the highest are in fish manufacturing and garments and leather. However, the ENRAP pollution intensities in certain sectors were significantly greater than the WB-IPPS. These included SS in chemical manufacturing with a ratio of 0.51 and SO_2 for other manufacturing with a ratio of 0.45. For petroleum refining, ENRAP SO_2, NOx, and VOC, ratios of 0.16, 0.53, and 0.25 were found. For some manufacturing sub-sectors, the ENRAP and WB-IPPS coefficients were found to be almost equal: SS in petroleum refining, BOD5 in metal manufacturing, PM in non-metal, VOC in other manufacturing, NOx in milled sugar and chemical manufacturing, and SO_2 in milled sugar as well as in metal manufacturing.

This might indicate weaknesses in the estimation methodology and technical assumptions of the ENRAP that may not capture all the ways in which Philippine technology differs from the technologies in developed countries. In those cases where the ENRAP coefficients are lower than the IPPS coefficients, only the IPPS intensities are used.

3.3 Simulation Results

3.3.1 Macroeconomic Effects

Table 9 presents the macro effects of the tariff reform program. For purposes of the analysis, the entire period is divided into two sub-periods: 1991-94 and 1995-99. The results are presented in period annual averages.

Over the entire period, the average impact of the program on real GDP growth is 0.32% per year. However, when broken down into the sub-periods, the second (1995-99) period shows a higher real GDP growth effect per year (0.51%) compared to the first (1991-94) period (0.08%).

The same pattern is observed in the rest of the macroeconomic results. With larger tariff reduction in the second period, imports increased by 2.7% per year. This effect is bigger than the 0.30% increase per year in the first period. This bigger drop in tariff rates in the second period however results in a substantial drop in government tariff revenue by –43.7% per year, as compared to only –0.60% drop per year in the first period. Positive effects on real GDP growth in the second period imply a higher government tax revenue from both direct and indirect sources. In spite of the increase, in net terms, the impact of the tariff reform program on government deficit is substantial, averaging Pesos -7 billion (USD -244.76 million) per year in the second period, as compared to only Pesos –1.9 billion (USD -66.4 million) per year in the first period.[3]

The impact of tariff reduction on prices is generally favorable. General import prices in local currency decline by –3.89% per year in the second period, substantially a higher drop than the first period of -0.14% per year. However, the composite price, which is the combined price of locally produced and imported goods, declines marginally by –0.15% per year in the second period, as opposed to a slight increase in the first period of 0.27% per year. Annual results, which are available but not presented in the table, indicate that the decline in the composite price is higher towards the end of the second period when the reduction in tariff rates is substantial.

The effects on factor prices are favorable as well. These have favorable impact on household incomes. The average wage rate increases by 1.79% per year in the second period, which is higher than in the first period i.e. an increase of 0.14% per year. The

3 Note that investment is shielded from the negative effects on government savings during the simulation with the closure assumption of fixed investment. In the analysis, with endogenous foreign savings, the tariff reform program in effect is being financed by foreign inflows.

average price of variable capital also increases by a higher rate of 2.76% per year in the second period, as compared to a decline in the first period of –0.1% per year. Since prices are declining, especially in the second period, this implies a higher rate of increase in real price of factors.

These resource allocation effects, which translate into higher output growth for other manufacturing, are more evident in the second period than in the first period. On average, other manufacturing grows by 2.32% per year in the second period as compared to 0.33% per year in the first period. Under the other manufacturing category, the specific industries which benefit the most in terms of output growth are the electrical equipment manufacturing, garments and textile as well as transport and other machinery (see Table 11). Within agriculture, large reductions are registered in fruits and vegetables, livestock and poultry, and fishing.

Table 9 Macroeconomic Effects

Economic Indicators	*Average*		
	1991-99	*1991-94*	*1995-99*
	Percentage (%)		
Real GDP Growth[a]	0.32	0.08	0.51
Imports[b]	1.63	0.30	2.70
Exports[b]	1.51	0.52	2.31
Government Budget Balance[c]	-3,976	-1.9	-7,155.5
% of GDP	-0.39	0.00	-0.71
Government Revenue[b]	-1.91	0.16	-3.56
of which:			
Tariff Revenue[b]	-24.55	-0.60	-43.70
Direct Tax Revenue [b]	1.29	0.17	2.19
Indirect Tax Revenue[b]	0.80	0.44	1.09
Price Changes[d]			
General Import Prices in Local Currency	-2.22	-0.14	-3.89
Composite Prices [e]	0.04	0.27	-0.15
Average Wage Rate[b]	1.06	0.14	1.79
Average Rent to Variable Capital[b]	1.49	-0.10	2.76

a Annual average growth difference from base run.

b Annual average % difference from base run.

c Annual average absolute difference from base run (in million Philippine pesos).

d Agriculture, mining, and manufacturing.

e Prices of locally produced and imported goods.

1991-99: (average exchange rate) 28.6 pesos=1 USD

1991-94: 26.63 pesos= 1 USD

1995-99: 32.32 pesos= 1 USD

Table 10 presents the simulation results on output and factor input of major sectors while Table 11 shows the effects on specific industry output. The tariff reform program results in noticeable resource allocation effects. Resources tend to move out of the primary sector towards manufacturing, in particular, to other manufacturing sector. On average, manufacturing grows by 0.86% during the period 1991-99. Agriculture declines by 0.19% while mining drops by 0.54% during the same period. On average, construction and services decline by 0.50% and 0.15%, respectively, between 1991 and 1999. Utilities expand by 0.30% during the same period.

Table 10 Sectoral Output and Factor Inputs: Major Sectors

		Factor Inputs		
Average: 1991-99	*Output*	*Labor*	*Variable Capital*	*Capital*
	Percentage (%)			
Agriculture	-0.19	0.15	-0.25	-0.29
Mining	-0.54	-1.06	-1.44	0.00
Manufacturing	0.86	1.08	0.79	0.58
Food Manufacturing	0.09	0.64	0.00	0.00
Other Manufacturing	1.44	1.38	1.74	1.44
Construction	-0.50	-0.15	-0.54	-1.02
Utilities	0.30	1.39		-0.01
Services	-0.15	-0.36	0.08	-0.24
Average: 1991-94				
Agriculture	-0.04	-0.16	-0.02	0.02
Mining	0.15	0.30	0.54	-0.02
Manufacturing	0.18	0.57	0.30	-0.02
Food Manufacturing	-0.02	-0.24	0.03	0.00
Other Manufacturing	0.33	1.15	0.62	-0.05
Construction	-0.36	-0.18	0.06	-0.75
Utilities	-0.21	-0.83		-0.02
Services	-0.07	-0.09	-0.05	-0.06
Average: 1995-99				
Agriculture	-0.32	0.40	-0.42	-0.54
Mining	-1.08	-2.15	-3.02	0.00
Manufacturing	1.40	1.48	1.19	1.06
Food Manufacturing	0.17	1.35	-0.02	0.00
Other Manufacturing	2.32	1.57	2.63	2.63
Construction	-0.62	-0.13	-1.03	-1.24
Utilities	0.71	3.17		-0.01
Services	-0.22	-0.57	0.19	-0.38

Table 11 Output by Specific Industries

Sectors	*Average*		
	1991-99	1991-94	1995-99
	Percentage (%)		
Palay & Corn	-0.03	0.03	-0.07
Fruits & Vegetables	-0.39	0.04	-0.74
Coconut & Sugar	0.22	0.33	0.13
Livestock & Poultry	-0.34	-0.05	-0.56
Fishing	-0.27	-0.34	-0.22
Other Agriculture	0.04	-0.01	0.07
Forestry	-0.21	-0.28	-0.15
Mining	-0.54	0.15	-1.08
Rice & Corn Milling	0.00	0.04	-0.04
Milled Sugar	0.13	-0.14	0.35
Meat Manufacturing	0.07	0.08	0.05
Fish Manufacturing	-0.24	-0.15	-0.31
Beverage & Tobacco	0.43	-0.06	0.81
Other Food Manufacturing	0.14	-0.10	0.33
Textile Manufacturing	1.49	0.63	2.19
Garments & Leather	4.81	2.13	6.96
Wood Manufacturing	-0.15	-0.37	0.02
Paper & Paper Products	-0.37	-0.19	-0.52
Chemical Manufacturing	0.06	-0.16	0.23
Petroleum Refining	-0.16	0.93	-1.03
Non-metal Manufacturing	0.03	-0.42	0.39
Metal Manufacturing	-0.75	-0.96	-0.59
Electrical Equipment Manufacturing	7.77	2.79	11.75
Transport & Other Machinery Manufacturing	1.84	-1.85	4.79
Other Manufacturing	-0.35	-0.41	-0.30
Construction	-0.50	-0.36	-0.62
Electricity, Gas & Water	0.30	-0.21	0.71
Financial Sector	-0.01	-0.09	0.06
Private Education	0.24	-0.12	0.54
Private Health	0.31	0.02	0.54
Public Education	0.00	0.00	0.01
Public Health	0.02	-0.01	0.05
General Government	-1.68	0.14	-3.14
Other Services	0.01	-0.11	0.11

Annual average % difference from base run.

3.3.2 Income Level and Income Distribution Effects

Table 12 presents the effects of the program on household income level and its distribution. Income effects are measured in terms of equivalent variation, while the distribution effects are measured by the income growth of households and the Gini coefficient.

Table 12 Income and Distribution

Equivalent Variation (Pesos million)	Average 1991-99	1991-94	1995-99
Hh1	83	(24)	169
Hh2	146	(35)	291
Hh3	195	(39)	382
Hh4	240	(46)	470
Hh5	281	(47)	543
Hh6	331	(53)	639
Hh7	367	(46)	698
Hh8	427	(46)	805
Hh9	619	(46)	1,151
Hh10	1,643	(96)	3,034
Household Total	4,333	(477)	8,182
Disposable Income (in %)			
Hh1	1.29	0.01	2.31
Hh2	1.28	0.02	2.29
Hh3	1.28	0.03	2.28
Hh4	1.27	0.03	2.26
Hh5	1.26	0.04	2.23
Hh6	1.23	0.05	2.18
Hh7	1.18	0.07	2.08
Hh8	1.14	0.08	1.99
Hh9	1.16	0.09	2.01
Hh10	1.24	0.08	2.16
Gini Coefficient	-0.02	0.03	-0.06
Ratio: EV/Disposable Income (in %)			
Hh1	0.45	-0.13	0.91
Hh2	0.47	-0.12	0.94
Hh3	0.49	-0.10	0.97
Hh4	0.49	-0.10	0.97
Hh5	0.49	-0.09	0.95
Hh6	0.47	-0.08	0.92
Hh7	0.44	-0.06	0.84
Hh8	0.41	-0.05	0.77
Hh9	0.44	-0.03	0.81
Hh10	0.54	-0.03	0.99
Household Total	0.48	-0.05	0.91

Annual average % difference from base run

Hh=household

1991-99: (average exchange rate) 28.6 pesos= 1 USD

1991-94: 26.63 pesos= 1 USD

1995-99: 32.32 pesos= 1 USD

Generally, the effects are favorable both in terms of household income level and its distribution. The removal of tariff distortion leads to an increase in income, averaging Pesos 8 billion (USD 279.7 million) per year in the second period. Interestingly, this is higher by Pesos 1 billion (USD 34.97 million) per year than the average increase in government deficit, as we have seen earlier. There is an average net loss in income in the first half, which can be attributed to the increase in tariff rates in some sectors, like agriculture.

The income distribution effects are favorable as well. The Gini coefficient declines by – 0.06% per year in the second period. This implies an improvement in income distribution. In terms of specific household groups, the first decile, which is the poorest group, registers the highest increase in income of 2.31% per year in the second period. The lowest is the 8th household group. The favorable effects on factor prices observed earlier translate to positive effects on household incomes, especially in the second period relative to the first period.

Table 12 also shows the ratio of equivalent variation over household disposable income. On average, the increase in real income in the second period is less than 1% of the income, in particular 0.91%. Among all the household groups, it is the tenth decile, the richest group, which benefits the most, with a ratio of 0.99%. One reason is because this group benefits greatly from higher consumption when tariff distortion is reduced. The group has the highest consumption of imported goods relative to the rest of the household groups.

3.3.3 Emission Effects

Air Pollutants

Sulphur Dioxide (SO_2). As a result of the tariff reform program, emission of this substance increases by an average of 0.19% per year from the base run (refer to Table 13). The biggest contributor is the utilities sector with an average increase of 251 tonnes per year over the period under study. Other manufacturing comes second, but in terms of specific industries (see Table 14), the increase comes from textile (31 tonnes), non-metal manufacturing (20 tonnes), transport and other machinery (15 tonnes) and electrical equipment (14 tonnes).

Nitrogen Oxides (NOx). There is also an increase in the emission of NOx as a result of the tariff program. The average total increase is 97 tonnes, or about 0.11% from the base run. The biggest sector contributing to this increase is other manufacturing, but in terms of specific industries, the largest increase still comes from the utilities sector.

Carbon Monoxide (CO). The increase in the emission of this pollutant is very small relative to the base run. The annual average increase over the period is 167 tonnes, representing an average increase of 0.05% from the base run. The increase comes from electrical equipment manufacturing, transport and other machinery, garments and textile.

Volatile Organic Compounds (VOC). Emission of this substance increases by an annual average of 100 tonnes, representing 0.14% increase from the base run values. The biggest contributor is transport and other machinery.

Fine Particulates (PM). There is a decline in the emission of PM pollutant as a result of the tariff program. The annual average decline over the period is –124 tonnes, representing about –0.25% of the base run emission. Major reduction comes from the mining sector, metal manufacturing, and construction.

Table 13 Emission by Major Sectors, 1991-1999

Sectors	*Annual average change, (in tonnes)*						
	SO_2	NOx	CO	VOC	PM	BOD5	SS
Total Economy	298	97	167	100	-124	-191	-99,026
Agriculture	-1	-2	-5	-1	-2	-636	-31,045
Mining	-32	-25	-124	-21	-108	0	-64,065
Manufacturing	89	106	446	141	40	199	342
Food Manufacturing	16	13	56	9	41	62	66
Other Manufacturing	73	93	390	132	-1	136	276
Construction	-3	-6	-33	-6	-56	0	0
Utilities	251	43	3	1	18	0	207
Services	-7	-19	-118	-15	-17	246	-4,464
	Annual average % difference from base run						
Total	0.19	0.11	0.05	0.14	-0.25	-0.09	-0.03
Agriculture	-0.27	-0.28	-0.20	-0.19	-0.37	-0.17	-0.40
Mining	-0.54	-0.53	-0.54	-0.55	-0.54	0.00	0.22
Manufacturing	0.17	0.34	0.37	0.56	-0.16	0.52	-0.34
Food Manufacturing	0.10	0.11	0.09	0.09	0.07	0.18	0.00
Other Manufacturing	0.20	0.45	0.51	0.80	-0.32	1.09	0.05
Construction	-0.51	-0.51	-0.51	-0.48	-0.51	0.00	-0.21
Utilities	0.30	0.30	0.25	0.09	0.31	0.00	0.00
Services	-0.26	-0.31	-0.36	-0.13	-0.20	0.02	0.00

Water Pollutants

Biological Oxygen Demand (BOD5). Emission from this pollutant declines by an average of –191 tonnes per year, which is -0.09% from the base run. The biggest drop comes from livestock and poultry industry.

Suspended Solids (SS). Emission from this substance declines by an annual average of –99,000 tonnes for the period. This is very small, representing –0.03% of the base run emission. Of this the biggest drop comes from mining, palay and corn, and forestry.

Note that the model does not include the impact of trade liberalization on natural resource depletion. Nonetheless, the effects could be roughly inferred from the changes in primary production. As Table 11 shows, most primary production is reduced by trade liberalization. On average, fruits and vegetables declined by 0.39%, livestock and poultry dropped by 0.34%, while fishing decreased by 0.27% during the period 1991-1999. Forestry declined by 0.21% while mining is reduced by 0.54%. Although there are some agricultural sectors that have expanded (coconut and sugar increased by 0.22% and other agriculture rose by 0.04%), on the whole, the agricultural sector registered a net decline of 0.19%. This tends to suggest that there would be less depletion as a result of the implementation of trade reforms in the country.

Table 14 Emission by Industry Sector

Sectors	*SO_2*	*NOx*	*CO*	*VOC*	*PM*	*BOD5*	*SS*
	Tonnes						
Palay & Corn	0	0	0	0	0	-67	-13,236
Fruits & Vegetables	0	-1	-2	0	-1	-12	-2,308
Coconut & Sugar	0	0	0	0	0	8	1,496
Livestock & Poultry	0	-1	-2	0	-1	-497	-3,579
Fishing	-1	-1	-1	-1	0	0	0
Other Agriculture	0	0	-1	0	0	-2	-287
Forestry	0	-1	-1	0	-1	-66	-13,132
Mining	-32	-25	-124	-21	-108	0	-64,065
Rice & Corn Milling	-1	0	-1	-1	-1	-1	-1
Milled Sugar	2	2	6	1	6	3	3
Meat Manufacturing	2	2	6	1	6	3	3
Fish Manufacturing	-1	-1	-2	-1	-2	-1	-1
Beverage & Tobacco	8	5	19	3	4	47	49
Other Food Manufacturing	6	6	29	5	28	12	13
Textile Manufacturing	31	12	46	8	10	61	29
Garments & Leather	8	14	77	13	12	20	31
Wood Manufacturing	2	4	20	4	4	0	0
Paper & Paper Products	-8	-3	-17	-2	-20	-8	-11
Chemical Manufacturing	5	2	11	2	8	2	1
Petroleum Refining	-3	-6	-76	-3	-3	-4	-1
Non-metal Manufacturing	20	15	29	5	10	0	2
Metal Manufacturing	-10	-5	-17	-3	-70	-1	-2
Electrical Equipment Manufacturing	14	30	160	27	24	0	200
Transport & Other Machinery Manufacturing	15	30	156	82	24	65	28
Other Manufacturing	0	0	1	1	1	0	0
Construction	-3	-6	-33	-6	-56	0	0
Electricity, Gas & Water	251	43	3	1	18	0	207
Financial Sector	0	0	1	0	0	0	0
Private Education	0	0	0	0	0	0	0
Private Health	0	0	1	7	0	6	3
Public Education	0	0	0	0	0	0	0
Public Health	0	0	0	0	0	0	0
General Government	-9	-23	-141	-30	-25	0	-4,495
Other Services	2	4	21	8	8	240	29

Annual average absolute change, 1991-1999.

3.4 Sensitivity Analysis on Possible Technology Effects

There are at least two possible effects of improved technology: it may reduce pollution intensity that results in lesser emission per unit of output produced and it may have positive effects on productivity that translates into higher output per unit of input. A sensitivity analysis was conducted to get some broad insights on how the above simulation results may change with improved technology. This involved the following exercises:

(a) An exogenous 5% reduction in the pollution intensities of selected industries with relatively high pollution coefficients (defined as **tech_p** in the simulation exercise). These industries were chosen on the basis of their present ENRAP coefficients, which are relatively higher than the rest of the industries. These covered the pollution coefficients of the following industries:

1. Electricity, gas and water. (SO_2, NOx)
2. Mining. (CO, VOC, PM)
3. Wood manufacturing (CO, VOC)
4. Forestry (BOD5, SS)
5. Metal (BOD5)
6. Private health (VOC)
7. Public health (VOC)

(b) Since there is no available information on the effect of improved technology on productivity, a sensitivity test involving various assumed increases in the production scale parameter of the seven industries above was conducted. In principle, this exercise amounts to having a higher total factor productivity growth in these industries as a result of improved technology. In this experiment, the following rates were used: 0.25%, 0.33%, 0.5%, and 1%. These are called tech_a in the experiments. In all experiments conducted, reduced tariff rates were assumed.

Table 15 Sensitivity Analysis of Possible Effects of Technology Improvement

tech_a[*] *tech_p*[**]	*No Technology Improvement*	*0.25%* *5.00%*	*0.33%* *5.00%*	*0.50%* *5.00%*	*1.00%* *5.00%*
Substance					
SO_2	0.19	-2.69	-2.66	-2.59	-2.40
NOx	0.11	-0.86	-0.84	-0.79	-0.64
CO	0.05	-0.92	-0.90	-0.85	-0.72
VOC	0.14	-0.96	-0.94	-0.91	-0.78
PM	-0.25	-0.78	-0.76	-0.70	-0.54
BOD5	-0.09	-1.51	-1.49	-1.45	-1.34
SS	-0.03	-0.03	-0.03	-0.03	-0.03
Income Effects: Total Equivalent Variation (in million Philippine pesos)					
1991-1999	4,333	4,487	4,538	4,641	4,945
1991-94	(477)	(326)	(276)	(174)	125
1995-99	8,182	8,338	8,389	8,493	8,801

These are percentage differences from base run average for 1991-99.

* exogenous rate of increase in production scale parameter in selected industries

** exogenous rate of decrease in pollution intensity in selected industries

1991-99: (average exchange rate) 28.6 pesos= 1 USD

1991-94: 26.63 pesos= 1 USD

1995-99: 32.32 pesos= 1 USD

The results presented in Table 15 include the impact on total emission per substance as a percent from the base under various assumed technology improvements. The results also show the impact on total income as measured by equivalent variation.

It is evident from the results that tariff reform together with improvement in technology can lead to substantial and favorable effects on the level of emission of pollutants. In the case where there is no improvement in technology, tariff reform resulted in higher emission (although small) of SO_2, NOx, CO, and VOC. However, with a 5% lower pollution coefficients in the seven industries listed above, the emissions of all pollutants dropped.

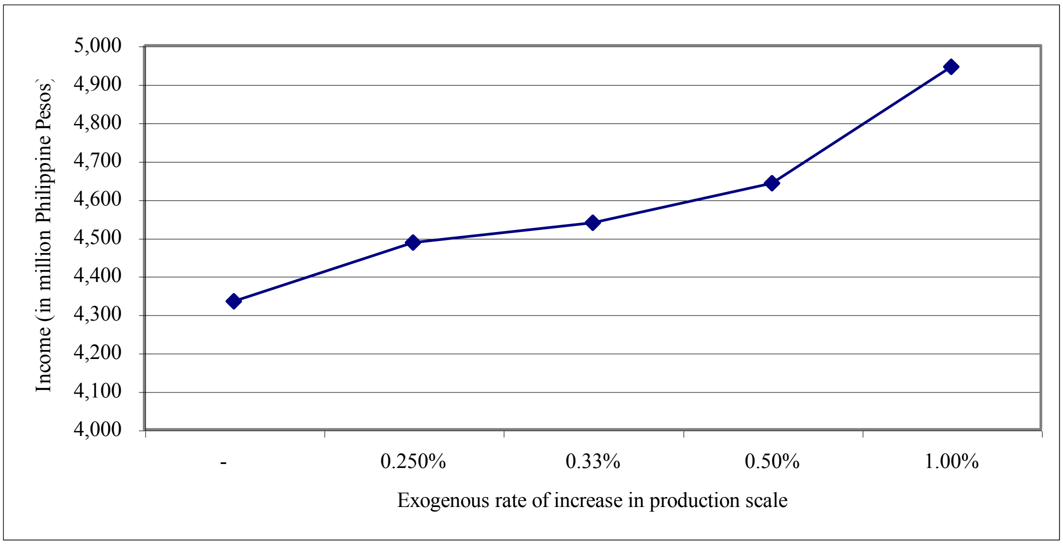

Figure 2 Effects of Technology Improvement on Total Income

1991-99: (average exchange rate) 28.6 pesos= 1 USD

1991-94: 26.63 pesos= 1 USD

1995-99: 32.32 pesos= 1 USD

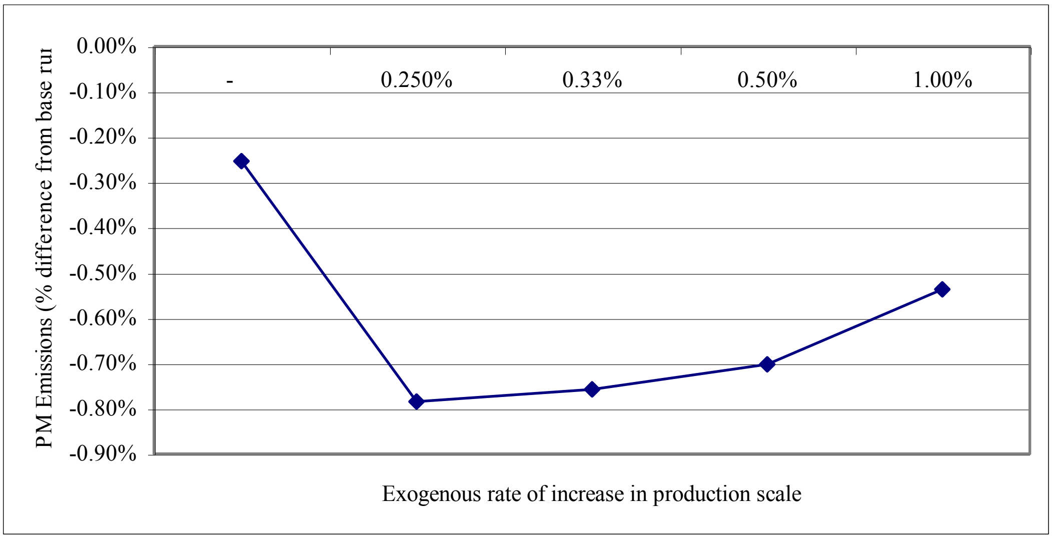

Figure 3 Effects of Technology Improvement on PM Emissions

The dynamics of the possible effects of improvement in technology on total income and pollution can be observed in Figures 2 and 3, respectively. Assuming variant tech_a and constant tech_b, Figure 2 plots the effects on total income measured by the equivalent variation while Figure 3 plots the effects on PM emissions. Higher total factor productivity (TFP) in selected industries is the force that drives total equivalent variation (EV) to increase. In fact, higher TFP growth in these selected industries resulted in higher EV for both sub-periods, 1991-94 and 1995-99. However, since **tech_p** is assumed fixed at 5% from the base coefficient, higher output that comes from higher **tech_a** results in smaller improvements in emission for PM, that is, the emission percentage difference from the base declines. If overall welfare is to be measured in terms of economic benefits as well as cleaner environment, then technological improvement in a regime of tariff reform should be both productivity-enhancing and environment-friendly.

3.5 Limitations of the Model

On the whole, the results of the experiments indicate some possibility of economic gains from the tariff reform program. Trade liberalization leads to changes in relative prices, which drive resources to move towards the manufacturing sector. This indicates some possibilities of favorable industrialization. Appendix 2 describes the opportunities and challenges posed by liberalization. With trade reforms, industries that used to be protected in the past are exposed to international competition. Trade liberalization thus eliminates economic policy distortions, creates effective competition, promotes economic growth and improves the efficiency of resource use; trade reforms are compatible with efforts to protect the environment. The sensitivity analysis indicates that overall welfare effect measured in terms of economic benefit and cleaner environment in a period of tariff reform can be augmented if there is technology improvement that is both productivity-enhancing and environment friendly.

Furthermore, trade reforms result in improvements in income and income distribution. With respect to air and water pollution, trade liberalization leads to a reduction in the emissions of PM, BOD5, and SS. While the results show some increase in the emissions of SO_2, NOx, CO, and VOC, these are only very small. Overall, there is an improvement in the environment, at least in terms of air and water pollution, relative to the case where there is no tariff reform program.

Note that income gains to a country resulting from trade reforms will increase the demand for environmental quality and make new investments in pollution abatement affordable. It will also increase political pressures for stricter enforcement of environmental regulations and greater investments in clean technology. Recent empirical work by Grossman and Krueger (1993) suggests that income gains can have a significant effect on some types of pollution emissions. Improvements in living standards are also associated with reductions in emission coefficients. Thus, trade liberalization seems to improve environmental quality through higher incomes which lead to improved technology and reduced emissions. Based on the results, gains may continue to accumulate as the government embarks on further trade reforms in the near future.

The results indicate that the impact of an improvement in production technology on the level of emission is significant. Moreover, the improvement widens as the tariff reform progresses. However, the experiments may have understated the impact on the level of emission because pollution coefficients were held fixed during the experiments. Production technology should be endogenous in the model as the country opens up to trade. Free trade affects the level of production technology favorably. Inflow of modern technology increases with import and export growth. However, this issue is too complex to be addressed in the present exercise. This is one future area where improvements could be made.

Another limitation of the model is the omission of utility gains from the improving environment. It would be useful to examine the implications of trade reform on the level and distribution of household welfare that incorporates environmental effects. Clearly, this kind of research would be another important extension, providing the necessary guidelines and directions for policy-makers.

4.0 CONCLUSION AND POLICY IMPLICATIONS

The model developed in this paper represents an attempt to examine the impact of trade liberalization on industrial pollution using the CGE method. The results indicate that trade policy reforms in the Philippines will substantially change the level and composition of output and consumption. Compared with the no trade policy reform base case, the CGE simulations show that the trade liberalization scenario led to a 0.08% increase in real GDP growth between 1991 and 1994 and then by a further 0.5% between 1995 and 1999.

The trade reforms will also increase the country's trade and change the sectoral shares of its GDP. The agricultural and other natural resource-based sectors will decline in relative importance as the manufacturing industries grow. From 1991 to 1999, agricultural output is expected to decline by 0.19% on the average, while mining will fall by 0.54%. Forestry and fishing will decrease by 0.21% and 0.27%, respectively, during the same period. These changes suggest that trade liberalization will result in less rather than more depletion of natural resources.

The CGE simulations suggest that, at least with respect to air and water pollution, trade liberalization in the Philippines would reduce the emissions of some pollutants and would add only slightly to environmental degradation. Even without changing our environmental policies, the simulations indicate that trade liberalization will improve the environment with respect to PM, BOD5, and SS and will only result in very slight environmental degradation in terms of SO_2, NOx, CO, and VOC emissions. The pollution effects are very small: SO_2 increases by 0.19%, NOx rises by 0.11%, CO by 0.05%, and VOC by 0.14%. PM declines by 0.25%, BOD5 falls by 0.09%, and SS reduces by 0.03%.

The results also show that trade liberalization brings substantial improvements in real income and induces improvements in income distribution with the highest income gains accruing to the poorest household group. Note that increases in income and improvements in living standards are associated with reductions in emission coefficients. The results tend to suggest that trade reforms may improve environmental quality through higher income which lead to improved technology and reduced emissions. Higher income permits more rapid investment in capital goods, which are likely to be cleaner. Moreover, with improvements in income due to trade liberalization, the political pressure for environmental clean up and greater investments in clean production technologies intensifies.

The sensitivity analysis on the effect of technology improvement indicates the critical role of technology effects in controlling pollution. As the results showed, introducing changes in technology together with trade reforms will lead to a large significant impact in improving the environment. Note that the total equivalent variation or the maximum amount the total households would be willing to pay for cleaner technologies increased as the improvement in the level of technology rose.

However, it is important to recognize the limitations to the current model used in the study. Of these, the most severe is the lack of data for estimating emissions coefficients in the Philippines. The pollution coefficients derived in the study should be treated as speculative and not as a substitute for the actual measurement of emissions coefficients. Given the still poor quality of data, caution should be used in interpreting the results. As shown here, there are some pollutants whose ENRAP coefficients are significantly lower than their WB-IPPS counterparts. This may indicate some shortcomings in the estimation procedure and assumptions used by the ENRAP. It would also be useful to perform some sensitivity analysis to see whether or not these results are robust to the use of other parameters like pollution intensities. Nonetheless, despite these limitations, the results suggest that trade liberalization may have beneficial effects on the environment via its effect on income and output growth. The fear that liberalizing trade in developing countries will lead to pollution havens might be overly pessimistic.

The results presented here apply only to air and water pollution and do not include other important environmental problems such as natural resource depletion. The impact of resource depletion is large, but modelling the effects is hampered by the lack of data. As improved environmental data become available, the model could be extended to incorporate changes in both resource depletion and the environment. As earlier indicated, trade reforms in the Philippines are expected to change the composition of output towards a reduction in natural resource-based sectors such as agriculture, mining, forestry, and fishing. Endogenizing pollution coefficients in the model and modifying it to induce substitution towards less pollution intensive activities and the adoption of less-polluting technologies would also be another useful extension. Another important area where the model could be modified is the inclusion of utility gains from the improving environment. It would be helpful to examine the implications of trade reform on the level and distribution of household welfare that incorporates environmental effects. Identifying the impact of both economic and environmental changes arising from trade reforms on the different income groups would have important policy implications especially in reducing the social and economic costs of economic growth and environmental mitigation.

The government should continue its trade liberalization policies as well as other economic reforms aimed at promoting competition and efficiency in the economy. This is not to assert that trade policy should be used to address environmental problems. For as long as environmental regulations are effectively enforced, environmental policies are still more efficient and appropriate than trade policies in addressing environmental problems.

The absence of good quality data is a stumbling block to a better understanding and a comprehensive analysis of the impact of trade liberalization on industrial pollution. The regulating body, DENR, must improve its monitoring and data collection/management functions. Finally, there is a need to strengthen DENR's enforcement of environmental and resource policies in order to internalize some of the externalities associated with production and consumption expansion. When optimal economic and environmental policies are in place and are effectively enforced, economic growth will enhance social welfare. While trade liberalization can lead to environmental damage and resource depletion, overall welfare need not decline for as long as trade reforms are accompanied by optimal environmental policy that is efficiently implemented.

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APPENDIX 1

Detailed Description of the CGE Model

	Core Equations in PCGEM	Description
1	$pm_{it} = pwm_{it} \cdot er \cdot (1+tm_{it}) \cdot (1+itxrdom_{it})$	Import price
2	$pe_{it} \cdot (1+te_{it}) = pwe_{it} \cdot er$	Export price
3	$p_{it} \cdot x_{it} = pd_{it} \cdot xxd_{it} + pm_{it} \cdot imp_{it}$	Composite Price, tradable
4	$p_{in} = pd_{in}$	Composite price for non-tradable
5	$px_{it} \cdot xd_{it} = pl_{it} \cdot xxd_{it} + pe_{it} \cdot \exp_{it}$	Sales price, tradable
6	$px_{in} = pl_{in}$	Sales price, non –tradable
7	$pd_i = pl_i \cdot (1+itxrdom_i)$	Domestic prices
8	$pva_i \cdot va_i = px_i \cdot xd_i - \sum_j id_{ij} \cdot p_j$	Value added price
9	$pk_i = p_i$	Price of capital
10	$pindex = \sum_i pwts_i \cdot pva_i$	Price index
11	$xd_i \cdot vt = va_i$	Supply
12	$ri_i = inp_i \cdot xd_i$	Intermediate input
13	$id_{ij} = aij_{ij} \cdot ri_j$	Matrix of intermediate input
14	$va_{w\_vk} = ad_{w\_vk} \cdot l_{w\_vk}^{\alpha_{w\_vk}} \cdot v_{w\_vk}^{\beta_{w\_vk}} \cdot k_{w\_vk}^{\gamma_{w\_vk}}$	Value added, sectors with variable capital
15	$va_{n\_vk} = ad_{n\_vk} \cdot l_{n\_vk}^{\alpha_{n\_vk}} \cdot v_{n\_vk}^{\beta_{n\_vk}} \cdot k_{n\_vk}^{\gamma_{n\_vk}}$	Value added, sectors without variable capital
16	$l_i \cdot wage = va_i \cdot pva_i \cdot \alpha_i$	Demand for labor
17	$v_{w\_vk} \cdot rvk = va_{w\_vk} \cdot pva_{w\_vk} \cdot \beta_{w\_vk}$	Demand for variable capital
18	$rkap_{w\_vk} \cdot k_{w\_vk} = pva_{w\_vk} \cdot va_{w\_vk} - wage \cdot l_{w\_vk} - rvk \cdot v_{w\_vk}$	Returns to capital in sectors with variable capital
19	$rkap_{n\_vk} \cdot k_{n\_vk} = pva_{n\_vk} \cdot va_{n\_vk} - wage \cdot l_{n\_vk} - rvk \cdot v_{n\_vk}$	Returns to capital in sectors without variable capital
20	$xd_{it} = at_{it} \cdot (\theta_{it} \cdot \exp_{it}^{\kappa\_e_{it}} + (1-\theta_{it}) \cdot xxd_{it}^{\kappa\_e_{it}})^{(1/\kappa\_e_{it})}$	Composite supply, CET, tradable
21	$xd_{in} = xxd_{in}$	Composite supply, non-tradable
22	$\exp_{it} = xxd_{it} \cdot \left[(\frac{pe_{it}}{pl_{it}}) \cdot (\frac{1-\theta_{it}}{\theta_{it}}) \right]^{\tau\_e_{it}}$	Export supply
23	$x_{it} = ac_{it} \cdot (\delta_{it} \cdot imp_{it}^{-\rho\_m_{it}} + (1-\delta_{it}) \cdot xxd_{it}^{-\rho\_m_{it}})^{(-1/\rho\_m_{it})}$	Composite Good, CES, tradable
24	$x_{in} = xxd_{in}$	Composite Good, non-tradable
25	$imp_{it} = xxd_{it} \cdot \left[(\frac{pd_{it}}{pm_{it}}) \cdot (\frac{1-\delta_{it}}{\delta_{it}}) \right]^{\sigma\_m_{it}}$	Import demand
26	$ylbag = wage \cdot \sum_{ag} l_{ag}$	Labor income in agri.
27	$ylbnag = wage \cdot \sum_{nag} l_{nag}$	Labor income in non-agri.
28	$yvkag = rvk \cdot \sum_{ag\_vk} v_{ag\_vk}$	Variable capital income in agri.

29	$yvknag = rvk \cdot \sum_{nag\_vk} v_{nag\_vk}$	Variable capital income in agri.
30	$ykap = \sum_i rkap_i \cdot k_i - \sum_i depr_i \cdot k_i \cdot pk_i$	Capital income
31	$pri\_inc_{inst1} = dylbag_{inst1} \cdot ylbag + dylbnag_{inst1} \cdot ylbnag + dylbocw_{inst1} \cdot er \cdot ww \cdot ocw + dyvkag_{inst1} \cdot yvkag + dyvknag_{inst1} \cdot yvknag + dykap_{inst1} \cdot ykap + \sum_{inst2} \sec dinc_{inst1,inst2} \cdot pri\_inc_{inst2} + gv\_tran_{inst1} + er \cdot for\_tran_{inst1}$	Income of institution, except government
32	$gv\_inc = \sum_{it} tm_{it} \cdot imp_{it} \cdot pwm_{it} \cdot er + \sum_{it} itxrdom_{it} \cdot imp_{it} \cdot pwm_{it} \cdot er \cdot (1 + tm_{it}) + + \sum_{it} te_{it} \cdot \exp_{it} \cdot pe_{it} + \sum_i itxrdom_i \cdot pl_i \cdot xxd_i + dykap_{gv} \cdot ykap + \sum_{inst1} dtaxr_{inst1} \cdot pri\_inc_{inst1} + gv\_dtax + er \cdot for\_tran_{gv}$	Government income
33	$dispy_{inst1} = pri\_inc_{inst1} \cdot (1 - dtaxr_{inst1})$	Disposable income
34	$pri\_save_{inst1} = pri\_inc_{inst1} \cdot (1 - dtaxr_{inst1}) - \sum_{inst1} pri\_cc_{inst1,i} \cdot p_i - \sum_{inst2} \sec dinc_{inst2,inst1} \cdot pri\_inc_{inst1} - er \cdot for\_pay_{inst1}$	Savings of institutions, except govt
35	$\text{int}_i = \sum_j id_{i,j}$	Intermediate demand
36	$pri\_cc_{inst1,i} = dccmt_{inst1,i} \cdot apc_{inst1} \cdot dispy_{inst1}$	Consumption of institutions except govt
37	$inv_i \cdot p_i = dinv_i \cdot (tinv - \sum_j chstk_j \cdot p_j)$	Sectoral Investment
38	$cab = \sum_{it} (pwm_{it} \cdot imp_{it} - pwe_{it} \cdot \exp_{it}) - ww \cdot ocw + \frac{1}{er} \cdot wage \cdot for\_lb + \sum_{inst} for\_pay_{inst} - \sum_{inst} for\_tran_{inst}$	Balance of payments
39	$tinv = \sum_{inst1} pri\_save_{inst1} + gv\_save + cab \cdot er + \sum_i depr_i \cdot k_i \cdot pk_i$	Total Investment equals total savings
40	$\sup lbag + \sup lbnag + for\_lb = \sum_i l$	Labor market equilibrium
41	$\sup vkag + \sup vknag = \sum_{w\_vk} v_{w\_vk}$	Variable capital equilibrium
42	$x_{alxgv-sev} = \text{int}_{alxgv-se} + \sum_{inst1} pri\_cc_{alxgv-se,inst1} + gv\_cc_{alxgv-se} + inv_{alxgv-se} + chstk_{alxgv-se}$	Product market equilibrium except in general govt sector
43	$walras = x_{gv-\sec} - \text{int}_{gv-\sec} - \sum_{inst1} pri\_cc_{gv-se,inst1} - gv\_cc_{gv-se} - inv_{gv-se} + chstk_{gv-se}$	Walras law

VARIABLES:

*	**output and input prices**
$pm_{(it)}$	domestic price of imports for tradables
$pwm_{(it)}$	world prices of imports for tradables
$pe_{(it)}$	domestic price of exports
$pwe_{(it)}$	world prices of exports
er	exchange rate
$p_{(i)}$	composite prices
$pd_{(i)}$	domestic prices
$p1_{(i)}$	domestic prices without domestic indirect taxes
$px_{(i)}$	sales prices
$pk_{(i)}$	capital goods prices
$pva_{(i)}$	value added prices
pindex	price index also called GDP deflator
wage	average wage rate
rvk	average return to variable capital
$rkap_{(i)}$	sectoral return to capital
ww	international wage rate

*	**taxes**
$tm_{(it)}$	tariff rates
$te_{(it)}$	export tax or subsidies
$itxrdom_{(i)}$	domestic indirect tax rates
$dtaxr_{(inst1)}$	direct income tax rates
gv_dtax	value of direct income tax on government sector

*	**output - value added - and trade variables**
$x_{(i)}$	composite commodities
$xxd_{(i)}$	$xd_{(i)}$ less exports
$xd_{(i)}$	column sums in the SAM less imports
$va_{(i)}$	value added
$ri_{(i)}$	vector sums of intermediate inputs
$id_{(i,j)}$	matrix of intermediate inputs
$imp_{(it)}$	imports
$exp_{(it)}$	exports
*	**factor inputs**
$l_{(i)}$	demand for labor
$v_{(w\_vk)}$	demand for variable capital
$k_{(i)}$	demand for capital
suplbag	total supply of agriculture labor
suplbnag	total supply of non-agriculture labor
ocw	overseas contract workers
supvkag	total supply of variable capital in agriculture
supvknag	total supply of variable capital in non-agriculture
*	**income and savings**
ylbag	labor income in agriculture
ylbnag	labor income in non-agriculture
yvkag	variable capital income in agriculture
yvknag	variable capital income in agriculture
ykap	capital income except government
$pri\_inc_{(inst1)}$	income of institutions

gv_inc	income of government
$dispy_{(inst1)}$	disposable income of institutions
$pri\_save_{(inst1)}$	savings of institutions except government
gv_save	savings of government
tinv	total investment funds equal to total savings
$depr_{(i)}$	depreciation
cab	current account balance
*	**demand**
$int_{(i)}$	intermediate demand
$pri\_cc_{(inst1,i)}$	consumption demand of institutions except government
$gv\_cc_{(i)}$	consumption of government
$inv_{(i)}$	sectoral investment
$chstk_{(i)}$	sectoral change in stocks
*	**transfers**
$for\_tran_{(inst)}$	foreign transfers to institution
$for\_pay_{(inst)}$	interest payments to ROW
$gv\_tran_{(inst1)}$	government transfers to institutions
for_lb	labor payments to foreign labor
*	**walras law**
walras	variable to capture walras law

APPENDIX 2

The Tale of Two Philippine Industries

The sugar refining and cement manufacturing industries are two of the major industrial sources of water and air pollution in the Philippines. The two industries are not only pollution-intensive but are among the industries that have been, historically, heavily protected by the government. From one perspective, many inefficient and uncompetitive sugar refining firms that have an extremely poor environmental record is observed. On the other hand, there are indications that a number of cement firms are able to compete and are carrying out important measures to improve their environmental performance.

Case Study 1: Sugar Milling and Refining Industry
There are 35 sugar mills in the Philippines and most of them are old and inefficient. During the period 1990 to 2000, the production of raw sugar did not change much, although a downward trend was evident. Productivity has been declining. The industry's costs of production are still higher than Thailand, Australia, Brazil, or South Africa. Investments in new technology are limited to only a few firms. The same is true for environmental investments. Water pollution is a major problem in the industry. The mills discharge their wastewater into rivers, bays, creeks, and other bodies of water.

The sugar market is heavily controlled and regulated by the government through the Sugar Regulatory Administration. Despite the tariff reduction and removal of quantitative restrictions on sugar, no effective competition has emerged in the industry. Hence, there is very little incentive for firms to modernize and improve their efficiency. To address their pollution problem, it is necessary for the old and inefficient mills to attack the source: obsolete technology and inefficiency. Without looking at the fundamental source of their wastewater discharges, it would be difficult for them to compete and comply with environmental regulations and standards. The continued intervention of the Sugar Regulatory Administration in the market would delay the adoption of proper environmental approach to reduce pollution and significantly lower the growth of the industry. It is only by eliminating the remaining barriers to competition can the industry realize the expected economic and environmental gains from trade liberalization.

Case Study 2: Cement Manufacturing
In the cement industry, trade liberalization and deregulation policies particularly the abolition of government regulators were necessary to create effective competition in the industry as the conditions attached to the formulation and effective implementation of competition law and policy were insufficient. Prior to the Asian crisis, the production trend was rising and investments were growing. In 1994, the industry started to invest in capital equipment as part of its modernization and expansion program. The entry of foreign investors helped in increasing environmental awareness and accelerating the promotion and introduction of good environmental systems and adoption of ISO standards. To date, there are 5 cement companies with ISO 14001 certification.

Source: Aldaba and C. Cororaton (2001)

APPENDIX 3
ACRONYMS AND GLOSSARY

ACRONYMS

AFTA-CEPT	ASEAN Free Trade Area-Common Effective Preferential Tariff
BOD	Biochemical Oxygen Demand
CGE	Computable General Equilibrium
CO	Carbon Monoxide
DENR	Department of Environment and Natural Resources
EMB	Environmental Management Bureau
ENRAP	Philippine Environment and Natural Resources Accounting Project
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
NOx	Nitrogen Oxides
OECD	Organization for Economic Co-operation and Development
PCGEM	Philippine Computable General Equilibrium Model
PM	Fine Particulates
PSCC	Philippine Standard Commodity Classification
SO_2	Sulphur Dioxide
SS	Suspended Solids
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
VOC	Volatile Organic Compounds
WB-IPPS	World Bank- Industrial Pollution Projection System

GLOSSARY

Biochemical Oxygen Demand (BOD) - Organic water pollutants are oxidized by naturally occurring microorganisms. This biological oxygen demand removes dissolved oxygen from the water and can damage some fish species. Low levels of dissolved oxygen may enable disease-causing pathogens to survive longer in water. The most common measure of BOD is the amount of oxygen used by microorganisms to oxidize the organic waste in a standard sample of pollutant during a five-day period, hence, BOD5. (Hettige et al. 1994).

Equivalent variation (EV) - This is a common welfare measure which takes the old equilibrium incomes and prices and computes the change needed to achieve new equilibrium utilities. EV is the income change equivalent to the welfare gain due to a price change.

Numeraire – Refers to pegging the price of one of the goods to 1 and adjusting the other prices accordingly.

PM_{10} - In general, particulates are fine liquid or solid particles such as dust, smoke, mist, fumes or smog found in air emissions. Fine particulates (PM_{10}) are less than 10 micron in diameter and pose a great respiratory hazard. (Hettige et al. 1994).

Tariffication – Replacement of import or quantitative restrictions like quotas by tariffs which are more transparent measures.

Total Suspended Solids (TSS) - Small particles of non-organic, non-toxic solids suspended in waste water which settle as sludge blankets in calm-water areas of streams and lakes. This can smother plant life and purifying microorganisms, causing serious damage to aquatic ecosystems. (Hettige et al. 1994).

Total factor productivity (TFP) - This is a measure of technological progress and efficient input utilization of a firm, industry or a country.